Atmospheric corrections for topographic monitoring systems in landslides

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Goal

Testing the influence of atmosphere on automated total station measurements (EDM)

- in operating condition
- with distances up to 1 kilometers

- Network calibrations (periodic surveys)
- Continuous measurements (tracking)

Test site: ***Ponte Biola (Collagna, RE)***

Landslide risk factor for

- the National Road 63 "Passo del Cerreto"
- the Biola Creek

TEST 1: Atm corrections with different methods

- Periodic measures
- Network (RIF1, STA, RIF4 and RIF-tral adjustment
- Atmospheric Temperature, pressure and relative humidity (from each station)

	29/10/2010		
ID	T (°C)	P (mbar)	U (%)
RIF1	22	913	53
RIF Tral	18	911	61
STA	15	912	67

Method 1:

The CALCULATED correction is as follows:

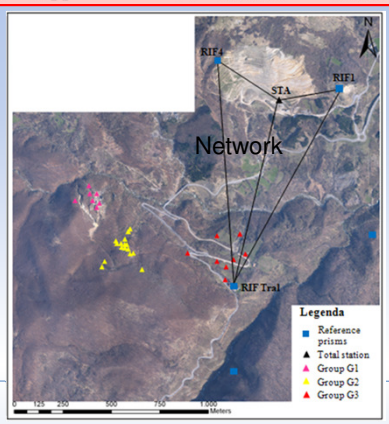
$$d = (nR / nL)\, d_{MEAS}$$

Where: d = corrected distance
nL = ambient refractive index
nR = reference refractive index (from the manufacturer's specifications for a given EDM instrument)
d_{MEAS} = measured distance

Method 2:

The INSTRUMENT correct distance is given by the ppm atm correction, calculated on the basis of atmpspheric values inserted in the instrument :

$$D_{CORR} = [\,(ppm / 1 \cdot 10^{6})\,(D_{MEAS})\,] + D_{MEAS}$$



TEST 1: Atm corrections with different methods

- Atmospheric temperature, pressure and relative humidity from the station to simulate the monitoring system architecture for continuous acquisition

	D measured	ppm calculated	ppm instrument	Δ correction
Station ID-Point ID	D0 meas (m)	Δ D1-D0 (mm)	Δ D2-D0 (mm)	Δ D2-D1 (mm)
RIF1- RIF tral	1097.22345	40.73	43.52	2.79
RIF1-STA	269.59065	10.01	10.56	0.55
STA-RIF1	269.58997	8.50	10.05	1.55
STA-RIF tral	958.86367	30.23	35.61	5.38
STA-RIF4	438.24613	13.82	16.55	2.73
RIF tral-STA	958.86382	33.04	28.49	4.55
RIF tral-RIF4	1158.85198	30.23	34.23	4.00
RIF tral-RIF1	1097.22248	37.80	42.66	4.86

Slope distances uncorrected (D0), atmospheric corrections ΔD1-D0 in mm (ppm), ΔD2-D0 in mm (ppm), comparison between the two corrections ΔD2-D1 (29/10/2010)

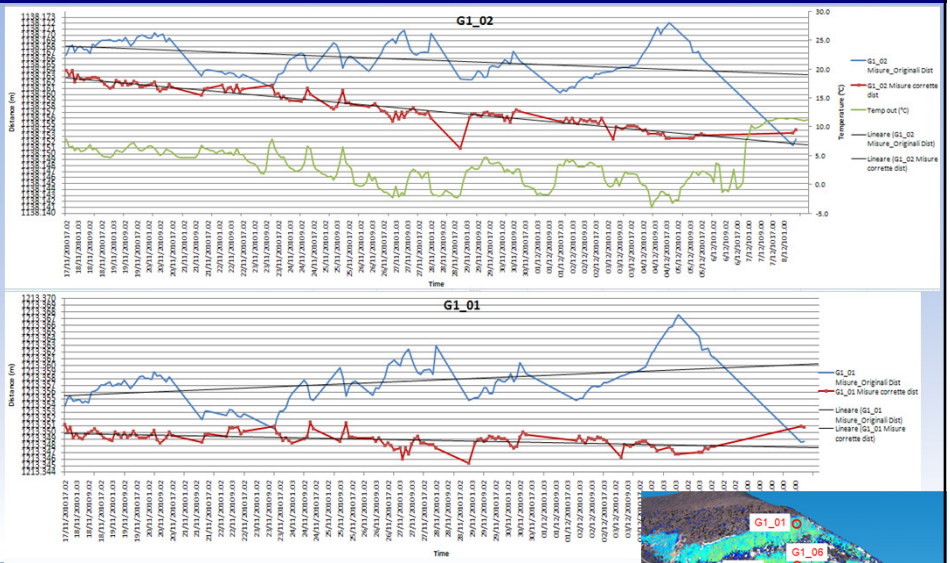
-The longer the distance, the bigger the magnitude of the difference between the corrections

- Some millimeters of difference on distances → A controlled process (calculated corrections) probably has to be preferred
→ Difference on coordinates within the precision of the method

	Δ C2-C1					
ID	ΔN (m)	ΔE (m)	ΔEl (m)	σ (N) (m)	σ (E) (m)	σ (El) (m)
STA	*0.0000*	*0.0000*	*0.0000*	***0.0000***	***0.0000***	***0.0000***
RIF1	-0.0008	*0.0000*	-0.0002	***0.0058***	***0.0000***	***0.0091***
RIF tral	-0.0082	-0.0046	-0.0200	***0.0120***	***0.0078***	***0.0250***
RIF4	0.0125	0.0107	-0.0024	***0.0086***	***0.0090***	***0.0207***

Comparison between adjusted corrected coordinates (29/10/2010)

TEST 2: Atmospheric ppm for continuous application



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Conclusions

- Atmospheric corrections seems to be necessary to improve the accuracy of the measured distance, when very little movements would be detected (in the order of the centimeter)
  - Corrected and uncorrected distances are quite different
  - With atmospheric corrections the noise of the measure reduces and a more clear behavior of prisms can be understood

  → the atmosphere influences a lot the measure of the distance

- The accurate centering of instruments and reflectors over the monument reference marks is very important for this kind of experiments and monitoring systems
- Difficult of identification of a proper geometry for the network calibration
  - Important! The conditions of stability of control points should be controlled over time as a guarantee of a correct interpretation of the whole landslide behavior
  - Tests performed with the verified (GPS campaigns and tiltmeter) hypothesis of stable master station and reference prisms
- Future works:
  - GPS campaigns for the comparison of the network distances with the GPS baselines
  - Further test for atm corrections and implementation of the algorithm to the monitoring system

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Thanks for your attention!

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